

**Landsat 7
Processing System (LPS)
Functional and Performance Specification**

Revision 1


July 28, 1995

**GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND**

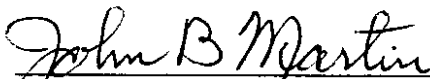
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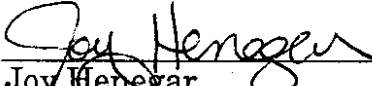
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Abstract

The Landsat 7 Processing System (LPS) will provide Level 0R, browse and metadata file(s) generation support to the Landsat 7 program, in conjunction with the Earth Science Mission Operations (ESMO) Project. The LPS is also funded to provide the Landsat 7 return link data record capability of the Landsat 7 Ground Station (LGS). This document specifies requirements to be met by the LPS which are in accordance with the Landsat 7 System Specification produced by the ESMO Project.

Keywords: Landsat 7
Landsat 7 Processing System (LPS)
Landsat 7 Ground Station (LGS)
Functional and Requirements (F&PR)
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(MO&DSD)
Systems Management Policy (SMP)

Preface

This Functional and Performance Specification (F&PS) contains detailed requirements for the LPS. The LPS detailed requirements are based on an analysis of the functional and performance requirements contained in the Landsat 7 System Specification and found to be allocated to the LPS. Once baselined at the system requirements review (SRR), this F&PS will serve as the primary source requirements document for the design and implementation of the LPS. The baselined LPS F&PS will be controlled by the Mission Operations and Systems Development Division (MOSDD) (Code 510) configuration control board (CCB) and maintained and updated, as required, by the LPS Project.

This F&PS was prepared by:

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Section 1 — Introduction

1.1 Purpose

The LPS will receive Landsat 7 recorded wideband data from the LGS, process to Level 0R, generate browse and metadata files, and provide them to the Land Processes Distributed Active Archive Center (LP DAAC). The LPS goals are the following:

- a. Provide Level 0R processing in support of the Landsat 7 ground segment.
- b. Minimize LPS development and operations costs to support Landsat 7 system implementation.

1.2 Scope

This document contains the detailed level functional and performance requirements for the LPS. These requirements are traceable to the Landsat 7 System Specification (Applicable Document 2), and are derived using the Goddard Space Flight Center (GSFC) Mission Operations and Data Systems Directorate (MO&DSD) practices or experience.

1.3 LPS Overview

An overview description of the LPS is contained in the LPS operations concept document.

Section 2 — Documentation

The following documents provide more detailed information regarding the LPS, interfacing systems, and external requirements.

2.1 Applicable Documents

These documents were used to derive requirements.

1. Consultative Committee for Space Data Systems (CCSDS), Recommendation for Space Data System Standards; Advanced Orbiting Systems (AOS), Networks and Data Links: Architectural Specification, Blue Book, CCSDS 701.0-B-1, Issue 1, October 1989
2. National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC) Landsat 7 System Specification, Review issue, 430-L-000-2-A, August 1994
3. Martin Marietta Astro Space (MMAS), Landsat 7 System Data Format Control Book (DFCB), Volume 4 - Wideband Data, Revision B 23007702-IVB, May 15, 1995
4. NASA GSFC, Interface Control Document (ICD) between the Landsat 7 Ground Station (LGS) and the Landsat 7 Processing System (LPS), Signature Copy, May 26, 1995
5. NASA GSFC, Interface Control Document between the EOSDIS Core System (ECS) and the Landsat 7 System, Working Draft, 209-CD-013-001, June 1995
6. NASA GSFC, Memo of Understanding (MOU) between the Landsat 7 Processing System and the Mission Operations Center (MOC), Draft, May 24, 1995
7. NASA GSFC, Interface Control Document between the Landsat 7 Processing System and the Image Analysis System (IAS), 23007630, 1995
8. NASA GSFC, Landsat 7 Detailed Mission Requirements, May, 1995

2.2 Reference Documents

These documents are used for background information.

1. GSFC/MO&DSD, Systems Management Policy, MDOD-8YMP/0485, July 1986.
2. NASA GSFC/MO&DSD, Landsat 7 Processing System (LPS) Operations Concept, Signature Copy, 560-3OCD/0194, December 28, 1994; and DCN 01, April 7, 1995.
3. National Aeronautics and Space Administration (NASA) Landsat 7 Level 1 Requirements, Draft Issue, August 8, 1994.
4. United States Geological Survey (USGS)/National Oceanic and Atmospheric Administration (NOAA), Index to Landsat Worldwide Reference System (WRS) Landsats 1, 2, 3, and 4, 1982
5. MO&DSD, Mission Operations Concept for the Landsat 7 Ground System, Draft, June, 1995.
6. Consultative Committee for Space Data Systems (CCSDS), Recommendation for Space Data System Standards, Telemetry Channel Coding, Blue Book, CCSDS 101.0-B-3, May 1992.

Section 3 — Functional Requirements

This section contains the functional requirements for LPS.

3.1 System Level Requirements

3.1.1 LPS shall provide the capability to support operations 24 hours per day, 7 days per week, on a continuous basis.

3.1.2 LPS shall provide the capability to support Landsat 7 operations for a minimum mission life of 5 years.

3.1.3 LPS shall provide the capability to receive, record and process 4 simultaneous wideband data inputs from the LGS, and deliver LPS output files.

3.1.4 LPS shall process wideband data inputs from LGS on a Landsat 7 contact period (return link wideband data recording session) basis.

3.1.5 LPS shall process wideband data to generate LPS output files on a received sub-interval basis.

3.1.6 LPS shall generate Landsat 7 return link quality and accounting data on a Landsat 7 contact period basis for each wideband data input.

3.1.7 LPS shall generate Level 0R quality and accounting data on a sub-interval basis for each LPS wideband data input.

3.1.8 LPS shall provide the capability to reprocess wideband data.

3.1.9 (requirement renumbered to 3.1.10.1)

3.1.10 The LPS shall provide an interactive intervention capability to detect and correct abnormal system conditions during LPS data capture and processing activities.

3.1.10.1 LPS shall provide a system start-up capability.

3.1.10.2 LPS shall provide a system shut-down capability.

3.1.10.3 LPS shall provide the capability to generate and report LPS error messages

3.1.10.4 LPS shall provide the capability to isolate system faults.

3.1.10.5 LPS shall provide the capability to recover from system faults.

3.1.10.6 LPS shall provide the capability to test LPS functions and external interfaces.

3.1.10.7 LPS shall provide the capability to execute diagnostic tests for verifying proper operation of system capabilities and components.

3.1.10.8 LPS shall provide the capability to support end-to-end testing of LPS functions.

3.1.11 LPS shall provide the capability to control LPS operations.

3.1.12 LPS shall provide the capability to monitor LPS operations.

3.1.13 (requirement renumbered to 3.1.10.3)

3.1.14 LPS shall provide the capability to configure system resources to support LPS operations (with normal or fall-back configurations).

3.1.15 (requirement renumbered to 3.1.10.4)

3.1.16 (requirement renumbered to 3.1.10.5)

3.1.17 (requirement renumbered to 3.1.10.6)

3.1.18 (requirement renumbered to 3.1.10.7)

3.1.19 LPS shall provide monitoring test points and indicators to verify proper operation of system capabilities and components.

3.1.20 LPS shall provide the capability to support software maintenance during LPS normal operations on a non-interruptive basis.

3.1.21 LPS shall permit corrective maintenance to be performed on failed equipment while the remainder of the system is actively satisfying mission critical functions not supported by that equipment.

3.1.22 LPS shall provide the capability to support preventive maintenance during LPS normal operations on a non-interruptive basis.

3.1.23 LPS shall provide the capability to support operator training during LPS normal operations on a non-interruptive basis.

3.2 External Interface Requirements

3.2.1 LPS shall interface with the Landsat 7 Ground Station (LGS) to receive wideband data as specified in Applicable Document 4.

3.2.2 LPS shall interface with the LP DAAC to coordinate the transfer of LPS output files to the LP DAAC (for detailed information refer to Applicable Document 5).

3.2.3 LPS shall interface with the Mission Operations Center (MOC) (for detailed information refer to Applicable Document 6).

3.2.4 LPS shall interface with the Image Assessment System (IAS) (for detailed information refer to Applicable Document 7).

3.3 Functional Requirements

This section contains requirements for specific functions of the LPS.

3.3.1 Receive Wideband Data

3.3.1.1 LPS shall provide the capability to receive return link wideband data inputs from LGS on a Landsat 7 contact period basis.

3.3.1.2 LPS shall provide the capability to receive return link wideband data inputs from LGS on an LGS output channel basis.

3.3.1.3 LPS shall store return link wideband data on a Landsat 7 contact period basis.

3.3.1.4 LPS shall store return link wideband data on an LGS output channel basis.

3.3.1.5 LPS shall provide the capability to retrieve stored return link wideband data on a Landsat 7 contact period basis.

3.3.1.6 LPS shall provide the capability to retrieve stored return link wideband data on an LGS output channel basis.

3.3.1.7 LPS shall provide the capability to record return link wideband data to removable storage media, on a Landsat 7 contact period basis.

3.3.1.8 LPS shall provide the capability to save removable storage media recorded with return link wideband data.

3.3.1.9 LPS shall provide the capability to retrieve return link wideband data from removable storage media.

3.3.1.10 LPS shall generate an LPS wideband data receive summary for each Landsat 7 contact period including the following:

- a. Contact period start and stop times
- b. Received data volume
- c. Received data volume in approximate number of Landsat 7 scenes
- d. (deleted)

3.3.1.10.1 LPS shall forward, via voice or FAX interface, the wideband data receive summary to the MOC within 5 minutes of data receipt at the LPS.

3.3.1.11 LPS shall coordinate the receipt of return link wideband data with LGS.

3.3.1.12 LPS shall maintain return link wideband data receipt capability during contact period anomalies.

3.3.1.13 LPS shall coordinate resolution of all data transfer problems with LGS.

3.3.2 Generate Level 0R File(s)

3.3.2.1 LPS shall perform Consultative Committee for Space Data Systems (CCSDS) Advanced Orbiting Systems (AOS) Grade-3 service on all received wideband Channel Access Data Units (CADUs) formatted in accordance with recommendations contained in Applicable Document 1.

3.3.2.2 LPS shall perform CADU synchronization on all received wideband data.

3.3.2.3 LPS shall provide the capability to detect and to synchronize on both normal and inverted polarity wideband data concurrently.

3.3.2.4 LPS shall utilize a Search/Check/Lock/Flywheel strategy for synchronization using the following selectable tolerances:

- a. Search tolerance of between 1 and 3 CADUs
- b. Check tolerance of between 0 and 3 CADUs
- c. (deleted)
- d. Flywheel tolerance of between 0 and 3 CADUs
- e. CADU synchronization marker Check error tolerance of between 0 and 3 bits
- f. CADU synchronization marker Lock error tolerance of between 0 and 3 bits

3.3.2.5 LPS shall invert all bits of each CADU detected to have inverted polarity.

3.3.2.6 LPS shall provide the capability to recover from bit slips, selectable between 0 and plus or minus 3 bits, in a CADU, by truncating or padding to the proper length.

3.3.2.7 LPS shall provide the capability to perform pseudo-random (PN) decoding of all received Virtual Channel Data Units (VCDUs) in accordance with the recommendations contained in Applicable Document 1.

3.3.2.8 LPS shall provide the capability to store all CADUs which have failed CCSDS Grade-3 service processing, on a Landsat 7 contact period basis.

3.3.2.9 LPS shall provide the capability to perform Bose-Chaudhuri-Hocquenghem (BCH) error detection and correction on the mission data zone contained in the VCDU (CCSDS processed data) in accordance with the Landsat 7 spacecraft data format information contained in Applicable Document 3.

3.3.2.9.1 LPS shall provide the capability to perform BCH error detection and correction on the data pointer zone contained in the VCDU (CCSDS processed data) in accordance with the Landsat 7 spacecraft data format information contained in Applicable Document 3.

3.3.2.10 LPS shall provide the capability to store all CADUs which have failed BCH error detection and correction on the mission data zone, on a Landsat 7 contact period basis.

3.3.2.11 LPS shall start a new sub-interval on detection of a change in the VCID.

3.3.2.12 LPS shall provide the capability to delete fill VCDUs.

3.3.2.13 LPS shall provide the capability to collect and store Landsat 7 return link (input) quality and accounting data, including the following information, for the wideband data received during each contact period:

- a. LPS string ID
- b. Contact period start and stop times
- c. CADU synchronization information (polarity, synchronization strategy and bit slips)
- d. Count of CADUs with synchronization errors
- e. Count of received CADUs
- f. Count of missing CADUs flywheeled
- g. (deleted)
- h. Count of correctable VCDU headers, by VCDU-ID (Reed Solomon checked)
- i. Count of uncorrectable VCDU headers, (Reed Solomon Checked)
- j. Count of CADUs with BCH errors corrected for the mission data zone in the VCDU

- k. Count of CADUs with BCH errors corrected for the data pointer zone in the VCDU
- l. Count of CADUs with BCH errors uncorrected for the mission data zone in the VCDU
- m. Count of CADUs with the BCH errors uncorrected for the data pointer zone in the VCDU
- n. Count of CADUs with Cyclic Redundancy Check (CRC) errors
- o. Approximate amount of wideband data received in megabytes
- p. Count of major frames received
- q. Approximate number of Enhanced Thematic Mapper Plus (ETM+) scenes received
- r. Approximate Bit Error Rate (BER) based on BCH detected and/or CRC bit errors

3.3.2.14 LPS shall locate ETM+ minor frames in each received VCDU as specified in Applicable Document 3.

3.3.2.15 LPS shall perform ETM+ major frame synchronization using ETM+ minor frames as specified in Applicable Document 3.

3.3.2.16 LPS shall provide the capability to band deinterleave Format 1 ETM+ data as specified in Applicable Document 3.

3.3.2.17 LPS shall provide the capability to band deinterleave Format 2 ETM+ data as specified in Applicable Document 3.

3.3.2.18 LPS shall provide the capability to reverse the order of data for ETM+ reverse scans.

3.3.2.19 LPS shall provide the capability to fill the following Landsat 7 data with preselected values:

- a. Full major frames
- b. Partial major frames

3.3.2.20 LPS shall provide the capability to extract Mirror Scan Correction Data (MSCD) on an ETM+ major frame basis.

3.3.2.21 LPS shall provide the capability to extract calibration data on an ETM+ major frame basis.

3.3.2.22 LPS shall provide the capability to perform integer-pixel alignment for each ETM+ band using sensor alignment information.

3.3.2.23 LPS shall provide the capability to determine ETM+ data sub-intervals.

3.3.2.24 LPS shall provide the capability to process wideband data to Level 0R.

3.3.2.25 LPS shall provide the capability to generate the following correlated Level 0R file(s) on a received sub-interval basis:

- a. ETM+ Image data
- b. Payload Correction Data (PCD)
- c. Mirror Scan Correction Data (MSCD)
- d. Calibration/DC Restore Data

3.3.2.26 LPS shall generate Level 0R quality and accounting data, including the following information, on a sub-interval basis:

- a. Sub-interval start and stop times
- b. Count of major frames in sub-interval
- c. CADU synchronization information (polarity, synchronization strategy and bit slips)
- d. Count of CADUs with synchronization errors
- e. Count of received CADUs
- f. Count of missing CADUs flywheeled
- g. (deleted)
- h. Count of correctable VCDU headers, by VCDU-ID (Reed Solomon checked)
- i. Count of uncorrectable VCDU headers, (Reed Solomon checked)
- j. Count of CADUs with BCH errors corrected for the mission data zone in the VCDU
- k. Count of CADUs with BCH errors corrected for the data pointer zone in the VCDU
- l. Count of CADUs with BCH errors uncorrected for the mission data zone in the VCDU
- m. Count of CADUs with BCH errors uncorrected for the data pointer zone in the VCDU
- n. Count of CADUs with CRC errors
- o. Count of entirely filled ETM+ major frames
- p. Count of partially filled ETM+ major frames
- q. BER (based on BCH and/or CRC detected bit errors)
- r. Imagery timecode errors

3.3.2.27 (deleted)

3.3.2.28 LPS shall append the status data contained in the VCDU mission data zone, as specified in Applicable Document 3, to Level 0R files(s) on a major frame basis.

3.3.2.29 LPS shall provide the capability to identify the presence of calibration door activities using information extracted from the PCD.

3.3.3 Generate Browse File(s)

3.3.3.1 LPS shall provide the capability to generate browse data for each ETM+ image sub-interval identified by LPS.

3.3.3.2 (deleted)

3.3.3.3 LPS shall provide the capability to generate multiband browse data from three predetermined bands of the ETM+ Format 1 scene data.

3.3.3.4 LPS shall include the following information on the browse data generated for each sub-interval:

- a. Sub-interval identification
- b. Sub-interval start and stop times
- c. Browsed data source band identification
- d. Browse processing information (e.g., reduction ratio)

3.3.3.5 LPS shall provide the capability to generate browse data using a predetermined reduction factor.

3.3.4 Generate Metadata File(s)

3.3.4.1 LPS shall provide the capability to synchronize on PCD bytes for assembling PCD minor frames as specified in Applicable Document 3.

3.3.4.2 LPS shall provide the capability to fill missing PCD data.

3.3.4.3 LPS shall provide the capability to assemble PCD major frames as specified in Applicable Document 3.

3.3.4.4 LPS shall provide the capability to generate PCD file(s) on a sub-interval basis.

3.3.4.5 LPS shall provide the capability to collect and store the following:

- a. PCD quality and accounting on a subinterval basis
- b. Processes PCD quality and accounting data on a subinterval basis
- c. Last instrument on/off times extracted from the PCD on a subinterval basis

3.3.4.6 (deleted; reference 3.3.4.5)

3.3.4.7 LPS shall provide the capability to perform ETM+ scene identification in accordance with the World Reference System (WRS) scheme (Reference Document 4).

3.3.4.8 LPS shall provide the capability to perform automatic cloud cover assessment (ACCA) for WRS scenes.

3.3.4.9 LPS shall provide the capability to perform ACCA on both scene quadrant and full scene basis.

3.3.4.10 LPS shall use parameterized comparison values in performing ACCA.

3.3.4.11 LPS shall generate Level 0R metadata (ancillary data) file(s) on a sub-interval basis.

3.3.4.12 LPS shall generate and include in each Level 0R metadata file the following Level 0R information, on a subinterval basis:

- a. LPS date and time the data is processed
- b. File version number
- c. LPS hardware string ID
- d. LPS software version number
- e. Landsat 7 spacecraft (per Applicable Document 3)
- f. Virtual Channel ID (per Applicable Document 3)
- g. Instrument ID (ETM+)
- h. Acquisition date
- i. Orbit number
- j. First and last scan time
- k. Number of scans
- l. Number of PCD major frames
- m. First PCD major frame time
- n. WRS path
- o. Starting row
- p. Ending row
- q. PCD file name
- r. Browse file name(s)
- s. Calibration data file name
- t. Mirror Scan Correction Data file name
- u. Level 0R data file name(s)
- v. Bands present
- w. ETM+ data format (Format 1 or Format 2)
- x. Last instrument on/off time
- y. IAS parameter version number

3.3.4.13 LPS shall generate and include in each Level 0R metadata file the following image quality data, on a scene basis:

- a. BER (based on BCH and/or CRC detected bit errors)
- b. CADU sync errors
- c. Total number of CADUs
- d. Number of missing CADUs
- e. VCDU header error control errors (Reed-Solomon)
- f. Number of corrected frames (BCH)

- g. Number of uncorrected frames (BCH)
- h. Number of bits corrected (BCH)
- i. Numbers of entirely filled major frames
- j. Numbers of partially filled major frames
- k. Imagery timecode errors

3.3.4.14 LPS shall generate and include in each Level 0R metadata file the following PCD quality and accounting data, on a scene basis:

- a. Number of failed PCD votes
- b. Number of PCD minor frames with sync errors
- c. Number of PCD filled minor frames
- d. Number of PCD filled major frames

3.3.4.15 LPS shall generate and include in each Level 0R metadata file the following processed PCD quality and accounting data, on a scene basis:

- a. Attitude data quality (i.e., quaternions)
 - 1. Number of data points
 - 2. Number of data points rejected
 - 3. Number of data point missing
- b. Ephemeris data quality
 - 1. Number of data points
 - 2. Number of data points rejected
 - 3. Number of data point missing

3.3.4.16 LPS shall generate and include in each Level 0R metadata file the following for each WRS identified scene:

- a. LPS scene number within the sub-interval
- b. WRS path
- c. WRS row
- d. Scene center time
- e. Scene center scan number
- f. Horizontal display shift
- g. Scene center latitude
- h. Scene center longitude
- i. Upper left corner latitude and longitude
- j. Upper right corner latitude and longitude
- k. Lower left corner latitude and longitude
- l. Lower right corner latitude and longitude
- m. Sun azimuth
- n. Sun elevation
- o. Cloud Cover Assessment (CCA) score (per quadrant)
- p. CCA (per WRS scene)
- q. CCA method
- r. (deleted)
- s. Gain change flag
- t. Band gains
- u. Calibration door events data

v. Day/night flag

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3.3.5 Transfer LPS File(s)

3.3.5.1 LPS shall notify LP DAAC on the availability of LPS files.

3.3.5.2 LPS shall coordinate the reporting of file transfer problems with the LP DAAC.

3.3.5.3 LPS shall provide the capability to receive notification from LP DAAC on the successful receipt of transferred LPS files.

3.3.5.4 LPS shall provide the capability to store LPS data files until confirmation of successful transfer is received from the LP DAAC.

3.3.5.5 LPS shall provide a manual override and protected capability to delete all LPS files on a specific contact period basis.

3.3.5.6 LPS shall provide a manual override and protected capability to retain all LPS files on-line on a specific contact period basis.

3.3.5.7 LPS shall provide the capability to generate LPS file(s) transfer summary, including the following information, on a daily basis:

- a. Count of Level 0R files available
- b. Count of Browse files available
- c. Count of Metadata files available
- d. (deleted)
- e. List of all files available
- f. Count of Level 0R files retained on-line
- g. Count of Browse files now retained on-line
- h. Count of Metadata files now retained on-line
- i. (deleted)
- j. List of all files now retained on-line
- k. Count of Level 0R files transmitted
- l. Count of Browse files transmitted
- m. Count of Metadata files transmitted
- n. List of all files transmitted
- o. Volume of data now retained on-line, in octets
- p. Volume of available on-line retention space, in octets

3.3.6 Control LPS Operations

3.3.6.1 LPS shall provide the capability to generate and modify LPS set-up tables from operator inputs.

3.3.6.2 LPS shall provide the capability to collect and report Landsat 7 return link quality and accounting data for each wideband data input on a Landsat 7 contact period basis.

3.3.6.3 LPS shall provide the capability to collect and report Level 0R quality and accounting data for each wideband data input on a sub-interval basis.

3.3.6.4 LPS shall display quality and accounting data upon operator request.

3.3.6.4.1 LPS shall print quality and accounting data upon operator request.

3.3.6.5 LPS shall provide the capability to display LPS file(s) transfer summary upon operator request.

3.3.6.5.1 LPS shall provide the capability to print LPS file(s) transfer summary upon operator request.

3.3.6.6 The LPS shall allow the operator to select thresholds for results and errors reported by the LPS.

3.3.6.7 LPS shall automatically generate messages and alarms to alert the operator of LPS results and errors exceeding selected thresholds.

3.3.6.8 LPS shall provide the capability to manually override the LPS automated functions.

3.3.6.9 LPS shall provide the capability to selectively enable and/or disable each of the following functions:

- a. Receive Wideband Data
- b. Generate Level 0R Files
- c. Transfer LPS Files

3.3.6.10 LPS shall provide a moving window display capability for the operator to view a reduced-size image of any of the ETM+ bands extracted from the wideband data being processed at each LPS input.

Section 4 — Performance Requirements

4.1 System Level Performance Requirements

4.1.1 (duplicate requirement deleted, reference Req 3.1.3)

4.1.2 (duplicate requirement deleted, reference Req 3.1.3)

4.1.3 LPS shall provide the capability to receive and process the equivalent of 250 Landsat 7 ETM+ scenes of wideband data per day (approximately 100 GB per day).

4.1.4 LPS shall provide the capability to move to 30 day storage and process the daily volume of wideband data within 16 hours of its receipt at LPS.

4.1.5 LPS shall provide the capability to reprocess a maximum of 10 percent of the daily input volume of wideband data (approximately 25 scenes or 10 GB per day).

4.1.6 LPS shall provide the capability to process received wideband data at an average aggregate rate of 12 megabits per second (Mbps) (Includes 10% of overhead due to reprocessing).

4.1.7 LPS shall provide online storage for temporary retention of LPS files for a maximum of 8 hours.

4.1.8 LPS shall introduce no more than one bit error in 10^9 bits.

4.1.9 LPS shall maintain data processing throughput performance for all Landsat 7 raw wideband data received with a BER of one bit error in 10^5 bits, without loss of level zero processed data and without retransmission.

4.1.10 LPS shall provide at least 110% of the processing throughput capability required to satisfy the worst case processor loading.

4.1.11 LPS shall provide at least 125% of the random access memory capacity required to satisfy the worst case memory loading.

4.1.12 LPS shall provide at least 125% of the peripheral storage capacity required to satisfy the worst case peripheral storage loading.

4.1.13 LPS shall provide at least 110% of the input/output band width required to satisfy the worst case input/output operations loading.

4.2 External Interface Performance Requirements

4.2.1 LGS-LPS interface shall provide the capability of transferring wideband data at a maximum rate of 75 Mbps per LPS wideband data input.

4.2.2 LPS-LP DAAC interface shall provide the capability to transfer the daily volume of LPS output files to LP DAAC at an average aggregate rate of 40 Mbps.

4.3 Functional Level Performance Requirements

4.3.1 LPS shall provide the capability to receive wideband data for Landsat 7 contact periods of up to 14 minutes.

4.3.2 LPS shall provide the capability to store wideband data for at least three contact periods for each LGS input until the start of a new (the fourth) contact period.

4.3.3 LPS shall provide the capability to retrieve stored wideband data at rates equal to or greater than 7.5 Mbps for each LPS input.

4.3.4 The LPS shall provide the capability to generate browse data with a reduction factor of 16 or better.

4.3.5 LPS shall provide the capability to identify ETM+ WRS scenes within an accuracy of 15 meters.

4.3.6 LPS shall provide the capability to retain return link wideband data storage media for 30 days.

4.4 Reliability, Maintainability, and Availability

4.4.1 LPS shall provide an Operational Availability (A_0) of 0.96 or better for all processing functions.

4.4.2 LPS shall support a mean time to restore (MTTRes) capability of 4 hours or better.

4.4.3 Any LPS time to restore shall not exceed twice the required MTTRes in 99 percent of failure occurrences.

Appendix A — Requirements Traceability Matrix

The following tables provide a traceability of the LPS requirements contained in the LPS F&PS to the LPS requirements contained in the Landsat 7 Detailed Mission Requirements (section 6200).

LPS F&PS Requirement	Landsat 7 Processing System F&PS Requirement Summary	L7 DMR Requirement
3.1. 1	support operations 24 hours per day, 7 days per week	6200.15
3.1. 2	support Landsat 7 operations for a minimum mission life of 5 years.	6200.15
3.1. 3	receive, record and process 4 simultaneous wideband data inputs.	6200.01 6200.01.01 6200.02 6200.02.02 6200.03 6200.04 6200.05
3.1. 4	process wideband data inputs from LGS on a Landsat 7 contact period basis.	6200.02
3.1. 5	process wideband data to generate LPS output files on a received sub-interval basis.	6200.02
3.1. 6	generate Landsat 7 return link quality and accounting data on a Landsat 7 contact period basis.	6200.06.03
3.1. 7	generate Level 0R quality and accounting data on a sub-interval basis	6200.25.01
3.1. 8	reprocess wideband data.	6200.02.05
3.1.10	provide an interactive intervention capability to detect and correct abnormal system conditions .	6200.15 6200.18
3.1.10.1	provide a system start-up capability.	6200.15
3.1.10.2	provide a system shut-down capability.	6200.15
3.1.10.3	generate and report LPS error messages	6200.25.02
3.1.10.4	isolate system faults.	6200.18
3.1.10.5	recover from system faults.	6200.18
3.1.10.6	to test LPS functions and external interfaces.	6200.16
3.1.10.7	execute diagnostic tests .	6200.16 6200.19
3.1.10.8	support end-to-end testing of LPS functions.	6200.16
3.1.11	control LPS operations.	6200.15
3.1.12	monitor LPS operations.	6200.25 6200.25.02
3.1.14	configure system resources to support LPS operations	6200.15 6200.18

3.1.19	provide monitoring test points and indicators	6200.16 6200.17 6200.25 6200.25.02
3.1.20	support software maintenance during LPS normal operations	6200.17
3.1.21	permit corrective maintenance .	6200.18
3.1.22	support preventive maintenance during LPS normal operations	6200.19
3.1.23	support operator training during LPS normal operations .	6200.20
3.2.1	interface with the LGS	6200.01 6200.01.01
3.2.2	interface with the LP DAAC	6200.03 6200.05 6200.07 6200.08
3.2.3	interface with the MOC	6200.01.03
3.2.4	interface with the IAS.	6200.09
3.3.1. 1	receive return link wideband data from LGS on a Landsat 7 contact period basis.	6200.01 6200.01.01
3.3.1. 2	receive return link wideband data inputs from LGS on an LGS output channel basis.	6200.01 6200.01.01
3.3.1. 3	store return link wideband data on a Landsat 7 contact period basis.	6200.01 6200.01.01
3.3.1. 4	store return link wideband data on an LGS output channel basis.	6200.01 6200.01.01
3.3.1. 5	retrieve stored return link wideband data on a Landsat 7 contact period basis.	6200.02 6200.02.05
3.3.1. 6	retrieve stored return link wideband data on an LGS output channel basis.	6200.02 6200.02.05
3.3.1. 7	record return link wideband data to removable storage media,.	6200.02.03
3.3.1. 8	save removable storage media recorded with return link wideband data.	6200.02.03
3.3.1. 9	retrieve return link wideband data from removable storage media.	6200.02.05
3.3.1.10	generate an LPS wideband data receive summary mate number of Landsat 7 scenes	6200.01.03
3.3.1.10.1	forward the wideband data receive summary to the MOC .	6200.01.03
3.3.1.11	coordinate the receipt of return link wideband data with LGS.	6200.01
3.3.1.12	maintain return link wideband data receipt capability during contact period anomalies.	6200.01 6200.01.01
3.3.1.13	coordinate resolution of all data transfer problems with LGS.	6200.01

3.3.2. 1	perform CCSDS AOS Grade-3 service on all received wideband CADUs	6200.01
3.3.2. 2	perform CADU synchronization on all received wideband data.	6200.02
3.3.2. 3	detect and t synchronize on both normal and inverted polarity wideband data	6200.02.02
3.3.2. 4	utilize a Search/Check/Lock/Flywheel strategy for synchronization	6200.02
3.3.2. 5	invert all bits of each CADU detected to have inverted polarity.	6200.02
3.3.2. 6	recover from bit slips,	6200.02
3.3.2. 7	perform pseudo-random (PN) decoding of all received VCDUs	6200.02
3.3.2. 8	store all CADUs which have failed CCSDS.	6200.02
3.3.2. 9	perform BCH error detection and correction on mission data zone in the VCDU	6200.02 6200.02.04
3.3.2. 9.1	perform BCH error detection and correction on the data pointer zone in the VCDU	6200.02 6200.02.04
3.3.2.10	store all CADUs which have failed BCH on the mission data zone,	6200.02 6200.02.04
3.3.2.11	start a new sub-interval on detection of a change in the VCID.	6200.02
3.3.2.12	delete fill VCDUs.	6200.02
3.3.2.13	collect and store Landsat 7 return link (input) quality and accounting data	6200.06.03
3.3.2.14	locate ETM+ minor frames in each received VCDU	6200.02
3.3.2.15	perform ETM+ major frame synchronization using ETM+ minor frames	6200.02
3.3.2.16	band deinterleave Format 1 ETM+ data	6200.02
3.3.2.17	band deinterleave Format 2 ETM+ data	6200.02
3.3.2.18	reverse the order of data for ETM+ reverse scans.	6200.02
3.3.2.19	fill full and partial major frames with preselected values:	6200.02
3.3.2.20	extract Mirror Scan Correction Data (MSCD) on an ETM+ major frame basis.	6200.02
3.3.2.21	extract calibration data on an ETM+ major frame basis.	6200.02
3.3.2.22	perform integer-pixel alignment for each ETM+ band using sensor alignment information.	6200.02
3.3.2.23	determine ETM+ data sub-intervals.	6200.02
3.3.2.24	process wideband data to Level 0R.	6200.02
3.3.2.25	generate ETM+ Image data, PCD, MSCD, and Calibration data on a received sub-interval basis.	6200.02

3.3.2.26	generate Level 0R quality and accounting data	6200.25 6200.25.01
3.3.2.28	append the status data contained in the VCDU mission data zone	6200.02
3.3.2.29	identify the presence of calibration door activities	6200.02.02
3.3.3.1	generate browse data for each ETM+ image sub-interval identified by LPS.	6200.04
3.3.3.3	generate multiband browse data from three predetermined bands of ETM+ Format 1 scene data.	6200.04
3.3.3.4	generate browse data for each subinterval	6200.04
3.3.3.5	generate browse data using a predetermined reduction factor.	6200.04
3.3.4. 1	synchronize on PCD bytes for assembling PCD minor frames	6200.06
3.3.4. 2	fill missing PCD data.	6200.06
3.3.4. 3	assemble PCD major frames	6200.06
3.3.4. 4	generate PCD file(s) on a sub-interval basis.	6200.06
3.3.4. 5	collect and store PCD quality and accounting, Processed PCD quality and accounting data ,Last instrument on/off times, on a subinterval basis	6200.06
3.3.4. 7	perform ETM+ scene identification in accordance with the WRS scheme	6200.06.01
3.3.4. 8	perform automatic cloud cover assessment (ACCA) for WRS scenes.	6200.06.02
3.3.4. 9	perform ACCA on both scene quadrant and full scene basis.	6200.06.02
3.3.4.10	use parameterized comparison values in performing ACCA.	6200.06.02 6200.09
3.3.4.11	generate Level 0R metadata (ancillary data) file(s) on a sub-interval basis.	6200.05
3.3.4.12	generate and include in each Level 0R metadata file the listed Level 0R information, on a subinterval basis.	6200.05 6200.06 6200.06.01 6200.06.03
3.3.4.13	generate and include in each Level 0R metadata file listed image quality data, on a scene basis	6200.05 6200.06 6200.06.03
3.3.4.14	generate and include in each Level 0R metadata file listed PCD quality and accounting data, on a scene basis	6200.05 6200.06 6200.06.03
3.3.4.15	generate and include in each Level 0R metadata file listed processed PCD quality and accounting data, on a scene basis	6200.05 6200.06 6200.06.03

3.3.4.16	generate and include in each Level 0R metadata file listed data for each WRS identified scene	6200.05 6200.06 6200.06.01 6200.06.03
3.3.5.1	notify LP DAAC on the availability of LPS files.	6200.03 6200.05 6200.07 6200.08
3.3.5.2	coordinate the reporting of file transfer problems with the LP DAAC.	6200.03 6200.08
3.3.5.3	receive notification from LP DAAC on the successful receipt of transferred LPS files.	6200.03 6200.08
3.3.5.4	store LPS data files until confirmation of successful transfer is received from the LP DAAC.	6200.08 6200.11
3.3.5.5	provide a manual override and protected capability to delete all LPS files on a specific contact period basis.	6200.08 6200.11
3.3.5.6	provide a manual override and protected capability to retain all LPS files on-line on a specific contact period basis.	6200.08 6200.11
3.3.5.7	generate LPS file(s) transfer summary	6200.25.02
3.3.6. 1	generate and modify LPS set-up tables from operator inputs.	6200.09 6200.17
3.3.6. 2	collect and report Landsat 7 return link quality and accounting data on a contact period basis.	6200.06.03
3.3.6. 3	collect and report Level 0R quality and accounting data on a sub-interval basis.	6200.25 6200.25.01 6200.25.02
3.3.6. 4	display quality and accounting data upon operator request.	6200.25.02
3.3.6. 4.1	print quality and accounting data upon operator request.	6200.25.02
3.3.6. 5	display LPS file(s) transfer summary upon operator request.	6200.25.02
3.3.6. 5.1	print LPS file(s) transfer summary upon operator request.	6200.25.02
3.3.6. 6	allow the operator to select thresholds for results and errors reported by the LPS.	6200.17
3.3.6. 7	automatically generate messages and alarms to alert the operator of LPS results and errors exceeding selected thresholds.	6200.25 6200.25.01 6200.25.02
3.3.6. 8	manually override the LPS automated functions.	6200.17
3.3.6. 9	selectively enable and/or disable Receive Wideband Data, Generate Level 0R Files, Transfer LPS Files functions	6200.17

3.3.6.10	provide a moving window display capability	6200.25 6200.25.02
4.1. 3	receive and process the equivalent of 250 Landsat 7 ETM+ scenes of wideband data per day (approximately 100 GB per day).	6200.01.01
4.1. 4	move to 30 day storage and process the daily volume of wideband data within 16 hours of its receipt at LPS.	6200.02
4.1. 5	reprocess a maximum of 10 percent of the daily input volume of wideband data (approximately 25 scenes or 10 GB per day).	6200.02.05
4.1. 6	process received wideband data at an average aggregate rate of 12 Mbps.	6200.02.05
4.1. 7	provide online storage for temporary retention of LPS files for a maximum of 8 hours.	6200.11 6200.23
4.1. 8	introduce no more than one bit error in 10 ⁹ bits.	6200.13
4.1. 9	maintain data processing throughput performance.	6200.21 6200.22
4.1.10	provide at least 110% of the processing throughput capability required .	6200.21
4.1.11	provide at least 125% of the random access memory required	6200.22
4.1.12	provide at least 125% of the peripheral storage capacity required .	6200.23
4.1.13	provide at least 110% of the input/output band width required.	6200.24
4.2.1	capability of transferring wideband data at a maximum rate of 75 Mbps per LPS input.	6200.01 6200.01.01
4.2.2	transfer the daily volume of LPS output files to LP DAAC at an average aggregate rate of 40 Mbps.	6200.03
4.3.1	receive wideband data for Landsat 7 contact periods of up to 14 minutes.	6200.14
4.3.2	store wideband data for at least three contact periods for each LGS input	6200.01.01 6200.02
4.3.3	retrieve stored wideband data at rates equal to or greater than 7.5 Mbps for each input.	6200.02 6200.02.05
4.3.4	generate browse data with a reduction factor of 16 or better.	6200.04
4.3.5	identify ETM+ WRS scenes within an accuracy of 15 meters.	6200.06.01
4.3.6	retain return link wideband data storage media for 30 days.	6200.02.03
4.4.1	provide an Operational Availability (Ao) of 0.96 or better for all processing functions.	6200.12
4.4.2	support a mean time to restore (MTTRes) capability of 4 hours or better.	6200.12

4.4.3	not exceed twice the required MTTRes in 99 percent of failure occurrences.	6200.12
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L7 DMR Requirement	Landsat 7 DMR Requirement Text	LPS F&PS Requirements
6200.01	The LPSf shall receive wideband data from the LGSf in CCSDS AOS format in real time.	3.1. 3 3.2.1 3.3.1.1 3.3.1.2 3.3.1.3 3.3.1.4 3.3.1.11 3.3.1.12 3.3.1.13 3.3.2.1 4.2.1
6200.01.01	The LPSf shall be capable of receiving the equivalent of 250 ETM+ scenes of wideband data per day either from the LGSf or in combination with data received from other compatible sites. LPS EXCEPTION: no data from other sites	3.1.3 3.2.1 3.3.1.2 3.3.1.3 3.3.1.4 3.3.1.12 4.1.3 4.2.1 4.3.2
6200.01.03	The LPSf shall send statistics and quality data to the MOCf after receipt and processing of wideband data from the LGSf.	3.2.3 3.3.1.10 3.3.1.10.1
6200.02	The LPSf shall process all wideband data received to level zero R, within 16 hours after receipt of the last data in a return link session, on a subinterval basis.	3.1. 3 3.1.4 3.1.5 3.3.1.5 3.3.1.6 3.3.2.2 3.3.2.4 3.3.2.5 3.3.2.6 3.3.2.7 3.3.2.8 3.3.2.9 3.3.2.9.1 3.3.2.10 3.3.2.11 3.3.2.12 3.3.2.14 3.3.2.15 3.3.2.16 3.3.2.17 3.3.2.18 3.3.2.19 3.3.2.20 3.3.2.21 3.3.2.22 3.3.2.23 3.3.2.24 3.3.2.25 3.3.2.28 4.1.4 4.3.2 4.3.3
6200.02.02	The LPSf shall provide products that are compatible with the standards specified in the Landsat 7 Coordinate Systems Standard.	3.1. 3 3.3.2.3 3.3.2.29
6200.02.03	The LPSf shall retain the raw wideband data for a minimum of 30 days from the time of receipt.	3.3.1. 7 3.3.1.8 4.3.6

6200.02.04	The LPSf shall perform Bose-Chaudhuri-Hocquenghem (BCH) error detection and correction decoding.	3.3.2. 9 3.3.2.9.1 3.3.2.10	
6200.02.05	The LPSf shall provide the capability to schedule, replay, and reprocess up to 10 percent of a day's raw wideband data on a daily basis.	3.1. 8 3.3.1.6 4.1.5 4.3.3	3.3.1.5 3.3.1.9 4.1.6
6200.03	The LPSf shall provide level zero R data to the LP DAAC.	3.1. 3 3.3.5.1 3.3.5.3	3.2.2 3.3.5.2 4.2.2
6200.04	The LPSf shall generate browse data on a subinterval basis.	3.1. 3 3.3.3.3 3.3.3.5	3.3.3.1 3.3.3.4 4.3.4
6200.05	The LPSf shall provide metadata and browse data to the LP DAAC with each level 0R archive entry to include information to describe, at a minimum, the following: 1. Geographic Area Coverage 2. Sensor 3. Date of Image Collection 4. Time profile of image collection 5. Sun Elevation Angle 6. Summarization of non-nominal data 7. Payload Acquisition Mode 8. Image processing quality 9. Cloud Cover Summary 10. Subsampled Data 11. Sensor Gain Mode 12. Last on/Last off instrument times	3.1. 3 3.3.4.11 3.3.4.13 3.3.4.15 3.3.5.1	3.2.2 3.3.4.12 3.3.4.14 3.3.4.16
6200.06	The LPSf shall generate metadata on both a subinterval and scene basis.	3.3.4. 1 3.3.4.3 3.3.4.5 3.3.4.12 3.3.4.14 3.3.4.16	3.3.4.2 3.3.4.4 3.3.4.11 3.3.4.13 3.3.4.15
6200.06.01	The LPSf shall identify scene boundaries (WRS reference on corner coordinates) for each scene within the associated metadata for each subinterval of level zero R data.	3.3.4. 7 3.3.4.16	3.3.4.12 4.3.5
6200.06.02	The LPSf shall perform cloud cover assessment.	3.3.4. 8 3.3.4.9 3.3.4.10	
6200.06.03	The LPSf shall provide return-link quality and accounting information for all wideband data as part of the metadata.	3.1. 6 3.3.4.12 3.3.4.14 3.3.4.16	3.3.2.13 3.3.4.13 3.3.4.15 3.3.6.2
6200.07	The LPSf shall provide metadata to the LP DAAC.	3.2.2 3.3.5.1	

6200.08	The LPSf shall coordinate with the LP DAAC regarding the availability of level zero R data, metadata, and browse data, and the successful transfer of the data.	3.2.2 3.3.5.2 3.3.5.4 3.3.5.6	3.3.5.1 3.3.5.3 3.3.5.5
6200.09	The LPSf shall receive processing parameters, data quality assessments, and problem reports from the IASf, as specified in the LPS-IAS ICD.	3.2.4 3.3.4.10 3.3.6.1	
6200.10	The LPSf shall receive schedule coordination information from the MOCf. LPS EXCEPTION: schedules from LGS to LPS	3.3.1.11	
6200.11	The LPSf shall provide the capability to store LPS data files until confirmation of successful transfer is received from the LP DAAC.	3.3.5.4 3.3.5.6	3.3.5.5 4.1.7
6200.12	The LPSf shall have an operational availability for data processing functions of 0.96 or better.	4.4.1 4.4.2 4.4.3	
6200.13	The LPSf shall introduce no more than one bit error in 10**9 bits processed.	4.1. 8	
6200.14	The LPSf shall be capable of recording 14 minutes of wideband data per return link session.	4.3.1	
6200.15	The LPSf shall provide mission operations for a minimum of 5 years.	3.1. 1 3.1.10 3.1.10.2 3.1.14	3.1.2 3.1.10.1 3.1.11
6200.16	The LPSf shall support integration and test prior to launch.	3.1.10.6 3.1.10.8	3.1.10.7 3.1.19
6200.17	The LPSf shall integrate, test and verify changes to LPS software, hardware, and databases without degradation of mission performance.	3.1.19 3.3.6.1 3.3.6.8	3.1.20 3.3.6.6 3.3.6.9
6200.18	The LPSf shall permit corrective maintenance to be performed on failed equipment while the remainder of the system is actively satisfying mission-critical functions not supported by that equipment.	3.1.10 3.1.10.5 3.1.21	3.1.10.4 3.1.14
6200.19	The LPSf preventive maintenance shall be planned and executed consistent with the system timeline and production constraints.	3.1.10.7 3.1.22	
6200.20	The LPSf shall support a staff training program that can be utilized during mission operations on a non-interruptive basis.	3.1.23	

6200.21	The LPSf shall provide ground operational computers each having, at delivery, at least 110% of the processing throughput capability required to satisfy the worst case processor loading.	4.1. 9 4.1.10
6200.22	The LPSf shall provide ground operational computers each having, at delivery, at least 125% of the random access memory capacity required to satisfy the worst case memory loading.	4.1. 9 4.1.11
6200.23	The LPSf shall provide ground operational computers each having, at delivery, at least 125% of the peripheral storage capacity required to satisfy the worst case peripheral storage loading.	4.1. 7 4.1.12
6200.24	The LPSf shall provide ground operational computers each having, at delivery, at least 110% of the input/output band width required to satisfy the worst case input/output operations loading.	4.1.13
6200.25	The LPSf shall produce indicators of system performance and data quality.	3.1.12 3.1.19 3.3.2.26 3.3.6.3 3.3.6.7 3.3.6.10
6200.25.01	The LPSf shall collect performance and quality data and deliver it with the metadata.	3.1. 7 3.3.2.26 3.3.6.3 3.3.6.7
6200.25.02	The LPSf shall provide for display of indicators of system performance and data quality and make them available to the system operators.	3.1.10.3 3.1.12 3.1.19 3.3.5.7 3.3.6.3 3.3.6.4 3.3.6.4.1 3.3.6.5 3.3.6.5.1 3.3.6.7 3.3.6.10

Glossary

Bit Error Rate (BER): The number of binary digits (bits) received in error divided by the total number of bits received over a specified time period.

Browse Image File: A reduced data volume file of the Level 0R data which can be viewed to determine general ground area coverage and spatial relationships between ground area coverage and cloud coverage. Browse image data from 3 predetermined bands of the ETM+ Format 1 scene data are contained in the multi-band browse file. This file contains reduced resolution scenes of the full resolution scene data contained in the Level 0R instrument data files of a sub-interval.

CCSDS Services: Services that are described in the Consultative Committee for Space Data Systems (CCSDS) Recommendations for Space Data Systems Standards, as specified in Applicable Document 1.

Channel Access Data Unit (CADU): A VCDU or coded VCDU (CVCDU) that has been prefixed and delimited by a synchronization marker, as specified in Applicable Document 1.

Daily average: The average computed over any continuous 24-hour period.

Data Capture: The receipt and storage of return link mission data at the CADU level.

Delay: The time elapsed between receipt of the last bit of the last data unit for a data product by a facility and the start of transmission of the first bit of that data product out of the same facility.

Interval: The time duration between the start and stop of an imaging operation (observation) of the Landsat 7 ETM+ instrument.

Landsat 7 Contact Period: The time duration between the start and end of wideband data transmissions from the Landsat 7 spacecraft to a ground station.

Level 0R Files: The reformatted, unrectified sub-interval data having a sequence of pixels which are spatially consistent with the ground coverage and appended with radiometric calibration, attitude, and ephemeris data.

Level 0R Instrument Data File: Each file contains the image data from a single band in a single subinterval. The data is grouped by detectors, i.e., for a given major frame, detector 1 data is followed by detector 2 data, etc. Reverse scans are reversed. This data is nominally aligned using fixed and predetermined integer values (provides alignment for band offset, even/odd detectors, and forward

and reverse scans). Quality indicators are appended for each major frame.

Calibration File: One file is created for each sub-interval. This file contains all of the calibration data received on a major frame basis for a given sub-interval. This is the data received after the Scan Line Data (which follows the End of Line Code) and before the next major frame sync, as described in Applicable Document 3. The data is grouped by detectors, i.e., for a given major frame, detector 1 data is followed by detector 2 data, etc. Reverse scans are reversed. The time of the major frame corresponding to this data is appended, as well as the status data.

Mirror Scan Correction Data (MSCD): One file is created for each sub-interval. This file contains the Scan Line Data extracted from the two minor frames following the End of Line Code in each major frame of the sub-interval. The Scan Line Data includes the first half scan error (FHS ERR), the second half scan error (SHS ERR), and the Scan direction (SCN DIR) information. The time of the major frame corresponding to this data is appended.

Payload Correction Data (PCD): One file created for each sub-interval. This file contains the PCD major frames received during a subinterval on a full PCD cycle basis. Quality indicators will be appended on a minor frame basis.

Level 0R Quality and Accounting Data: The data quality and accounting information collected by the LPS, on a sub-interval basis, from processing of the ETM+ major frames constructed from the wideband VCDUs received during a Landsat 7 contact period.

LPS Files: The generic term used to denote the grouping of Level 0R, the browse and the metadata files for a single sub-interval.

LPS String: A functional entity of the LPS responsible for end-to-end processing of the raw wideband data received from a return link channel (I or Q) of the X-band downlink data captured by the LGS.

Mean Downtime (MDT): The period of time consisting of mean time to repair (MTTR) plus administrative and logistics delays.

Mean Time Between Failures (MTBF): The mean time between failures measured during a specified operating period.

Mean Time To Repair (MTTR): The period of time consisting of the mean time required from failure detection, through troubleshooting, fault localization, removal and replacement of failed LRUs, adjustment/calibration of repaired equipment and verification that the specified performance requirements are met.

Mean Time To Restore (MTTRes): The mean time required to restore functionality, performance, and operational state existing prior to any failure.

Metadata: One metadata file is created for each sub-interval. The metadata contains information on the Level 0R data provided in the sub-interval, the names of the Level 0R instrument data, calibration data, payload correction data, mirror scan correction data and browse image files associated with the sub-interval. Metadata also contains quality and accounting information on the return link wideband data used in generating the level 0R file(s). In addition, metadata includes quality and accounting information on received and processed PCD, and cloud cover assessment for the WRS scene contained in the sub-interval. The metadata is used by the LP DAAC users to determine the sub-interval and/or WRS scene level quality of the Level 0R data stored in the LP DAAC archive before ordering it on a cost basis.

Mission Data: Spacecraft, instrument, and other data for a specific mission. Mission Data includes spacecraft return link data in raw and processed form.

Mission Critical Functions:

- Receive wideband data
- Generate Level 0R File(s)
- Generate Browse File(s)
- Generate Metadata File(s)
- Control LPS functions

Non-mission Critical Functions:

- Software maintenance
- Software development
- Preventive Maintenance
- Training

On-line: A capability or combination of capabilities is defined as being on-line when it is available for or currently supporting its allocated operational requirements.

Return Link Data: Mission Data originating on a spacecraft for transmission to the ground.

Return Link Quality and Accounting Data: The data quality and accounting information collected by LPS from CCSDS Grade 3 and BCH error detection and correction processing of the raw wideband data received from LGS on a Landsat 7 contact period basis.

Sub-Interval: A segment of raw wideband data interval received during a Landsat 7 contact period. Sub-intervals are caused by breaks in the wideband data stream due to communication dropouts and/or the inability of the spacecraft to transmit a complete observation (interval) within a single Landsat 7 contact period. The largest possible sub-interval can be as long as

a full imaging interval. The smallest possible sub-interval can be as small as one full ETM+ scene with a time duration of approximately 24 seconds.

Virtual Channels: A CCSDS architectural concept whereby a single physical channel may be shared by different types of users by creating multiple, apparently parallel "virtual" paths through the physical channel, as specified in Applicable Document 1.

Virtual Channel Data Unit (VCDU): A fixed-length CCSDS AOS data structure which is used bidirectionally for space/space or space/ground communications. A VCDU that includes forward error correction coding is referred to as a CVCDU and is implied by references to VCDUs, as specified in Applicable Document 1.

Acronym List

Ao	Operational Availability
AOS	Advanced Orbiting Systems
ACCA	Automatic Cloud Cover Assessment
BCH	Bose-Chaudhuri-Hocquenghem (error detection and correction scheme)
BER	Bit Error Rate
CADU	Channel Access Data Unit
CCB	Configuration Control Board
CCSDS	Consultative Committee for Space Data Systems
CRC	Cyclic Redundancy Check
CVCDU	Coded VCDU
ECS	EOSDIS Core System
EDC	EROS Data Center
EOSDIS	Earth Observation Data Information System
EROS	Earth Resources Observation System
ESMO	Earth Science Mission Operations
ETM+	Enhanced Thematic Mapper Plus (instrument)
F&PR	Functional and Performance Requirements
F&PS	Functional and Performance Specification
GByte	Gigabyte (1 x 10 ⁹ Bytes)
GSFC	Goddard Space Flight Center
IAS	Image Assessment System
ID	Identification
IPD	Information Processing Division
LCC	life-cycle cost
LGS	Landsat 7 Ground Station
LPS	Landsat 7 Data Processing System
LP DAAC	Land Processes Distributed Active Archive Center
LRU	Line Replaceable Unit
Mbps	megabits per second
MSCD	Mirror Scan Correction Data
MDT	Mean Downtime
MOC	Mission Operations Center

MO&DSD	Mission Operations and Data Systems Directorate
MTBF	mean time between failures
MTTR	mean time to repair
MTTRes	mean time to restore
NASA	National Aeronautics and Space Administration
NHB	NASA Handbook
PCD	Payload Correction Data
RMA	Reliability, Maintainability, and Availability
R-S	Reed-Solomon (error detection and correction scheme)
SMP	Systems Management Policy
SN	Space Network
STDN	Spaceflight Tracking and Data Network
TBD	To Be Defined/Determined
TBR	To Be Resolved
TByte	Terabyte (1×10^{12} Bytes)
VCDU	Virtual Channel Data Unit
VCDU-ID	VCDU Identifier
WRS	Worldwide Reference System